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ABSTRACT

This paper reports on a pilot project in which German universities in Freiburg, Constance, Mannheim, Stuttgart, and Ulm connected computer science departments via the Internet for a summer 1997 telelecture and teletutorial on computers and society. The first section provides background on telelearning and introduces the case study. The second section discusses the didactic approach (to give a conventional lecture and provide additional material via the World Wide Web), student participants, and the technological infrastructure that utilized a Mbone (Multicast Backbone) based videoconferencing toolset. The qualitative methods used to evaluate the pilot project are explained in the next section. The fourth section describes the experiences, difficulties, and lessons learned regarding the video conference toolset and the didactic approach. Findings indicate that: the videoconferencing tool provided insufficient quality of transmission and was deficient regarding its functionality and interface; the telelecture led to reduced attention of remote participants and a lower level of interactivity between lecturers and students; and telelearning requires new teaching and learning approaches to compensate for its constraints. Contains 13 references. (DLS)

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Lecture and Tutorial Via the Internet: Experiences from a Pilot Project Connecting Five Universities

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Lecture and Tutorial via the Internet - Experiences From a Pilot Project Connecting Five Universities

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Abstract: During the summer semester 1997 five German universities participated in a telelearning pilot project where a telelecture and -tutorial was held via the internet. Within this pilot project, we evaluated the m-bone based video conferencing tool as well as the applied didactic concept. The video conferencing tool provided insufficient quality of transmission and was deficient regarding its functionality as well as its interface. Concerning the telelecture we found reduced attention of the remote participants, and a lower level of interactivity between lecturers and students. Positive feedback regarding the tutorials which tried to encourage interactivity among the participant and regarding newly didactic elements within the lecture indicate that telelearning requires new teaching and learning approaches to compensate for its obvious constraints.

1. Introduction

Telelearning holds the premises of increased availability and reduced cost of education. Nevertheless the given technical constraints may reduce the efficiency of the learning processes. Each setting for telelearning faces this basic contradiction in a very specific manner. The basic challenge when arranging for any telelearning setting must be to gain the mentioned benefits without losing quality. Meeting this challenge requires an adequate technological infrastructure, an appropriate didactical concept, and a beneficial organizational embedment of the telelearning activities.

To analyze critical success factors in telelearning settings, case studies are required. In the following we will report about the experiences made in a pilot project connecting computer science departments of five German universities via the internet. The University of Freiburg is the only university in the south west German state of Baden-Württemberg where an institute is specialized in "Computers and Society". To allow students from the other locations to take a course in this subject, we offered to connect their universities by means of the internet. Thus, a lecture and a tutorial in "Computers and Society", normally just given in a face-to-face setting, were transmitted via an Mbone based video-conference application. Four universities (Constance, Mannheim, Suttgart and Ulm) decided to join this pilot project.

There are already quite some case studies which report on telelearning projects in the German university environment based on the same technological infrastructure (e.g.: Stucky et al. 1995, Eckert, Geyer and Effelsberg 1997). Nevertheless our case is specific concerning the following focal points:

- the rather big number of universities involved and its technological, didactical, and organizational implications,
- the combination of a telelecture and a teletutorial,
- the distinct didactic concept of the tutorial.

2 Didactical Approach, Students and Technological Infrastructure

During summer semester 1997 the authors carried out twelve lectures and seven tutorials on a weekly basis. To benefit from the rather favourable traffic-load in the internet, we hold the sessions in the earlier morning (8.15 a.m.-9.45 a.m.).

Regarding the telelecture the didactic concept was to give a conventional lecture and provide additional material via the WWW. The tutorial was intended to ground selected aspects of the lecture. As the education of computer scientists typically does not stress the development of communicative competence and as we

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assumed that this ability is nevertheless crucial for computer professionals, we tried to promote it by the way we set up the tutorials.

The tasks to work out in the tutorials asked the students to input statements which in some cases had to be prepared by carrying out interviews. These input statements were discussed in the following. We asked the students at the single locations to form groups to work out the tasks. Moreover, we established a mailing list in which all the participants were supposed to register for intergroup discussion. Finally the lecturers gave their telephone number and e-mail address to answer questions which could not be solved among the students. The students were supposed to deliver their solutions to the tasks via e-mail or by sending a http-address.

The number of participants (students and local support) at the fife different locations varied for the lecture between 22 and 8 with an average of about 15 and for the tutorial between 17 and 7 with an average of about 11. In the lectures as well as in the tutorials the highest number of participants joined the first session. The number declined gradually towards the end of the semester (cf. Wulf and Schinzel 1997).

The lecture and the tutorial were carried out based on a Mbone (Multicast Backbone) based videoconferencing toolset. Mbone protocols were running on top of the IP protocol of the Internet which had a bandwidth of 34 Mbps between the universities. Within the individual sites a typical configuration consisted of a university networks (FDDI, 100 Mbps) and a local network (Ethernet, 10 Mbps). The video conference toolbox contained an audio tool (vat), a video tool (vic), a shared whiteboard (wb) and an additional tool to synchronise the display of the shared whiteboard (wbimport) (cf. Eriksson 1994). We favoured this freeware toolset compared to commercial ones because we could run it on different hardware platforms.

In Freiburg and Ulm the sessions were hold in a lecture room. Thus, the screen of the connected workstations was - fully or partly - projected by a beamer. The audio was by loudspeakers, while microphones registered the local voices. The video was at each location caught by a single camera. In Constance, Stuttgart and Mannheim the participants followed the sessions in front of workstations which were placed in specific rooms. Thus, there was not any beamer display. While some of these workstations were equipped with a video camera (Mannheim and Stuttgart) and with headsets (Stuttgart), others were just equipped with microphones and loudspeakers.

3 Research Method

To evaluate the telelearning pilot project we have applied several qualitative methods. After each session the authors have written a report documenting the most important events. Moreover, we asked the local students in the end of each session to give us feedback. Following their feedback, we interviewed them individually or in small groups several times during the semester. In the second part of the semester, we used the video conference toolset, to get feedback in the end of the session from the remote participants.

One of the authors travelled once during the semester to each of the remote sites. After the corresponding session he had a group discussion with the students and the local support. In the last lecture we used the video conference toolset to discuss the experiences made with this type of telelearning. We used the shared whiteboard to ask the participants to type in anonymously positive and negative impressions on one slide. Based on this input we discussed advantages and disadvantages of the telelectures and -tutorials. In the second part of this lecture we discussed five thesis which the authors had distributed before via e-mail. The results of this discussion were documented and evaluated. Additionally we have achieved the e-mails exchanged and have written notes of the most important phone-calls concerning the lectures and the tutorials.

4 Experiences

4.1 Video Conference Toolset

The Mbone based toolset allowed us to hold the lecture as well as the tutorial during the whole semester, but nevertheless we experienced a lot of technical problems which challenged the patience and motivation of the participants. During the 19 sessions, we had four complete breakdowns of the Mbone-net which interrupted the connection to all external locations for 15 up to 45 minutes. The connection with Ulm was - especially due to frequent drop-outs of the voice channel - that bad that these students stopped participating after the first four weeks. The connection among the other locations were characterised by occasional problems of the voice channel especially in the second part of the section (after 9 a.m.) (cf. Wulf and Schinzel 1997). To reduce the netload, and thus to improve the quality of the audio channel, we often abandoned the video transmission in the second part of the session. It turned out that already short drop-outs of the voice channel can lead to serious

misunderstandings (cf. Wulf and Schinzel 1997). Based on the given infrastructure (bandwidth of the different networks and router capacity at the time of the study) there are severe problems in transmitting telelearning sessions by means of the Mbone-protocol. To allow for an undisturbed transmission between multiple locations bandwidth reservation seems to be indispensable (cf. Geyer, Eckert and Effelsbrg 1997).

Moreover, running the Mbone protocol requires the cooperation of actors administrating the different subnets who do not necessarily value the success of telelecturing in a sufficient way. These incongruent interests can lead to considerable problems. For instance, lacking attention of one of the local network administrators caused one of the complete breakdowns of the transmission. A sixth university did not participate due to lacking cooperation among the different network administrators.

Looking at the video application toolset, we found severe deficiencies in the design of the surface interface as well as of the functionality. Looking at the surface interface the design violates almost every principle of the ISO 9241 part 10 standard. For instance, the surface design is inconsistent between the individual applications as well as within single ones, e.g. the meaning of the mouse buttons differs within the audio tool. This inconsistency led to problems in communication within the first sessions because one of the authors occasionally failed to activate the audio channel when speaking. Moreover, the functionality of the toolbox is badly documented. For instance, it took us several attempts of cooperative exploration to build up an appropriate mental model of the different transmission modes of the audio tool and their mutual interrelations at the different sites.

Beyond the surface interface there were severe deficiencies of the toolsets' functionality, as well. The design of the audio tool's transmission modes inhibited the interactivity in the lectures and in the tutorials (cf. chapter 4.2). As the ambient noise resulting from the loudspeakers could not be suppressed automatically, formalised turn-taking protocols had to be applied which required to press a button before speaking. Neil (1997) reports about similar problems with videoconferencing tools when providing telelearning courses in a companies setting. Thus, research should be directed to allow for full duplex audio links.

The functionality of the shared whiteboard proved to be deficient, as well. The drawing functionality of the whiteboard is rather restricted. It mainly allows to annotate slides which have been imported. Its functionality is not sufficient to draw fully new slides. Nevertheless in the tutorial it turned out that there was a strong need to create slides spontaneously to visualise aspects of the discussion or to present multiple input on the screen (e.g.: technique described in chapter 3). Thus, the functionality of the shared whiteboard should be extended to the level of regular graphic editors. To collect multiple input, different turn taking protocols should be implemented in the whiteboard (cf. Greenberg 1991; Dommel and Garcia-Luna-Aceves 1997). This would allow to evaluate them in different learning scenarios.

Moreover, one should reconsider the given restriction to the keyboard as the sole input device. Electronic whiteboard with pen input devices would greatly encourage the simultaneous participation of different actors in creating graphics. Moreover, it turned out that typing on the keyboard and synchronously speaking is a difficult task. Here again a pen based input device would ease participation. Such an equipment would also encourage acceptance in scientific culture whose lecturing style is more based on blackboard than on slides (e.g. in mathematics).

The design of the shared whiteboard does not transmit the position of the pointer and movement of graphical elements to the remote locations. This design decision obviously limits the amount of data necessary to transmit. Nevertheless, it turned out during lectures and tutorials that the ability to spontaneously point to a graphical element or to encircle parts of a slide are very helpful in telecommunication. The implemented substitutes (creation and deletion of annotations) are not sufficient. Thus, in an new version movements of cursors and graphical elements should be transmitted at an appropriate level of granularity.

Moreover, the postscript based import-function of the whiteboard was not only badly documented but also badly implemented. It took us long lasting attempts involving various conversions and manipulations to import files created on Windows, Macintosh and Unix systems. Such problems are prohibitive for users who do not have a profound computer background.

Carrying out the lecture and tutorial it turned out that there is a need for additional tools for meta-communication. To compensate for the problems of the audio tool and to encourage interactivity, one should integrate a tool which allows remote participants to make the speaker aware of questions or remarks. Connecting just two locations Eckert, Geyer and Effelsberg (1997) have extended the video-conference toolset by implementing a "putting up of hands" tool. This tool should get extended to cover multiple locations. Meta-communication is needed furthermore to optimise technical aspects of the transmission among the different sites (e.g. position of the cameras, quality of the voice channel, transmission rate of the video channel). A

potential communication tool to use in these cases is the shared text editor which is included in the Mbone tool set.

4.2 Didactical Approach

As we have applied specific didactical approaches in the lecture and in the tutorial, we will look individually at the different experiences.

The first remarkable observation concerns the speed of lecturing. We were not able to present as many topics as in a face-to-face lecture. This fact is primarily caused by the many bigger and smaller technical breakdowns (cf. chapter 4.1). Beyond this we used additional time to collect verbal feedback from the remote locations (e.g. concerning: quality of transmission, attention and understanding). In a face-to-face situation this feedback is either not necessary or it can be implicitly collected by watching the audience. Feedbackwise, the video stream transmitted could not replace the physical presence of the auditorium.

Moreover, the participants at remote locations reported about a lower level of attention compared to face-to-face lectures. Those who followed the lecture from a terminal reported that they occasionally used their mail tool or their web browser during the lectures. Neil (1997b) hints to similar experiences when teaching in a multinational company. Obviously telelecturing implies the loss of social control which typically is imposed by the physical presence of the lecturer. Thus, the lecturer faces a stronger competition for the attention of the participants.

Like Geyer, Eckert and Effelsberg (1997), we experienced a low level of interaction between the lecturer and the participants. The first question of a student occurred after almost two months and was facilitated by a technical breakdown of the transmission. There are several reasons for this phenomenon. One of the local students in Freiburg stated that he did not want to disturb all the participants at the different locations by posing a question. A student from one of the remote universities explained that she hardly could recognise the appropriate moment for posing a question. In her eyes this problem is more severe if there is not any video of the lecturer. By contrary the lectures' failed in rising the interactivity when trying to pose questions to the remote participants. Due to a lack in context information, they were not able to detect the appropriate moment and the "right" partner. Moreover, the inappropriate transmission-modes of the audio tool and missing tools for metacommunication influenced the interactivity between lecturer and audience negatively (cf. chapter 4.1)

To increase the level of attention and interactivity, it turned out to be helpful to integrate additional slides into the lecture which asked the students questions about the content of the preceding chapter. These questions had to be answered immediately by textual input using the shared whiteboard. Based on the input we initialised a discussion especially when answers were wrong, incomplete or missing. This technique encouraged participation and gave us valuable feedback about the performance of the students.

The approach taken in the tutorial to encourage (tele-) communicative competence was appreciated by the students - especially in Constance and Ulm. Besides the considerable technical deficiencies of the video conference toolset, the students were able to give smaller talks which increased in quality during time. Moreover, they were able to participate in the occasionally controversial discussions. The participants especially appreciated the exchange of ideas with students from other universities which were often of rather different opinion. To start discussions it turned out to be helpful to ask the participants to express their point of view by typing text into the shared whiteboard (cf. chapter 3).

Due to the design of the audio tool, formal facilitation of the discussions was necessary (cf. chapter 4.1). Nevertheless there was a lack of context information which made it difficult for the facilitator to pass the right to speak among the participants. As not all of the sites were equipped with video cameras, it was impossible to see who puts up the hand to create a list of speakers. Furthermore it was difficult to predict which participant could contribute most appropriately to a current discussion. This led to problems in maintaining the focus of the discussion. Thus, to support tutorials which are strongly based on mutual interaction high quality video and tools for metacommunication seem to be indispensable.

Though we had asked the participants to introduce themselves within the first session of the tutorial, the students later reported about a feeling of anonymity towards each other. Occasionally they could not identify the speakers at the other sites or relate them to the introductive statements given in the first session. Thus, they reported about a feeling of emotional distance. Some of them suggest a face-to-face meeting of all the participants involved which should take place after the first month of lecturing. Nevertheless it was doubted whether there were sufficient resources of time and money for such a meeting. Thus, the students suggest to combine face-to-face and telelearning elements. Preece and Keller (1991) report about experiences with such a hybrid approach.

The perceived anonymity is contradictive to finding of Neil (1997 a and b) who used multiple technologies like videoconferencing, audioconferencing, and a variety of Internet-based conferencing to hold teleseminars in a multinational company. She found that students were surprisingly familiar with each other in the end of the class. However their seminar lasted only four weeks with sessions, typically scheduled three times a week for two hours. Thus, the contradictive findings may be explainable either by the shorter duration and higher density of Neil's teleseminar or by an in this respect more successful didactical approach. Anyhow, further research seems to be necessary in this point because the building of social networks is a crucial factor for the success of telelearning. In this respect the tutorial did not turn out to be successful. Neither within the different sites nor between the sites, the students built groups in solving the tasks of the tutorial. Moreover, the common mailing list was not used by the students to discuss between the sessions. It was merely used for announcements of the organisers.

Looking at the general attitude toward the telelearning pilot project, we found a significant difference in the attitude of the students in Freiburg compared to the remote sites - notably Constance and Ulm. From the beginning the students in Freiburg complaint about the disadvantages of telelearning:

- disturbance due to technical problems,
- interruption of the current lecture due to meta-communication with the remote sites,
- reduced attention of the lecturers towards the local students.

As they had regular courses in "Computers and Society" at their faculty, telelearning did not enlarge their curricula. Moreover, several of them had already experience with telelearning because this topic is a research focus of the Freiburg faculty (cf. Bacher and Ottmann 1996, Ottmann and Bacher 1995). Thus, we could not draw on their curiosity, either.

By contrary, the students at the remote sites appreciated the lecture and tutorial as an enrichment of their curriculum. They had a significantly more positive attitude toward the experiment though they suffered most from the technical breakdowns and deficiencies. Interestingly, Eckert, Geyer and Effelsberg (1997) also found that the students at the site where the lecture was held before in a face-to-face ensemble gave lower ratings than those at the remote sites. We believe that this attitude is rational because under the given circumstances the local students are losing quality of education without gaining an enrichment of their curriculum. To encourage their motivation one has to provide benefits to them like increased asynchronous availability of the lecturers or didactically elaborated material.

In carrying out both the lecture and the tutorial we experienced a significant higher workload for the lecturers compared to traditional courses. If one does not mention the overhead caused by the evaluation presented here, the following reasons have led to an increased workload:

- development of appropriate concepts for telelearning,
- higher standards for the layout of the material, e.g. slides,
- additional presentation of all relevant material by means of the web,
- higher efforts in asynchronous communication when supporting remote students,
- coordination with the local support at the remote sites,
- tests of the technical infrastructure,
- preparation of the organisational setting (contacting the remote faculties, arranging the time-table, booking lecture rooms etc.).

These additional tasks have to be kept in mind if one discusses the potential for cost reduction in education by means of telelecturing. Moreover, local support at all the remote sites is indispensible. As the preparation of didactic material is rather resource intense, there is the danger of an too extensive reuse of this material over time. This may lead to an outdated contend of telelearning courses.

From our experience it is crucial to plan and prepare courses in telelearning early in advance. We started to contact the remote faculties about four month before the first session was supposed to take place. In some cases this time span turned out to be insufficient. For instance, it was too late to get our course included in the printed programs of these faculties. As the faculties had planned their programs already, it was moreover difficult to get resources for the local support.

To develop new ideas for the use of the video conferencing tool in telelearning, the feedback of the students and of the local support proved to be very helpful. Quite some ideas presented here resulted form group discussions after the sessions. Moreover, it proved helpful for all of the participants to join a presentation of an experienced speaker. In our case a collegue providing local support in Mannheim had profound experience in telelecturing. His presentation in one of the tutorials was a source of inspiration for the following speeches. This experience hints to the fact that lecturers should be supported by specialists

transferring teleteaching experience. Especially in the beginning such a support seems to be crucial to develop appropriate didactical concepts for telelearning.

5. Conclusion

We have reported about experiences gained form a telelecture and teletutorial on „Computers and Society" carried out in summer semester 1997 connecting five German universities. We evaluated the applied toolset as well as the didactical approach taken. It turned out that bandwidth reservation is indispensable to support our didactical approach. Moreover, the video-conferencing toolset proved deficiently designed concerning its surface interface as well as concerning its functionality. The telelecture turned out to lead to a lower level of attention and interactivity. To us it is an open question whether new didactical elements like the ones presented here will overcome these problems. The positive perception of the tutorials hints to the fact that telelearning requires new didactic concepts which involve the students more actively than lectures typically do.

Nevertheless our experiences are based on just one case. Our results are influenced by factors such as the topic of the courses, the personalities of the actors and the technology applied. Thus, these results have to get compared to further case studies. Tackling the problems presented, synchronous telelecturing has the potential to make education more easily available. Nevertheless, it is doubtful whether it will be more lecturer-time efficient than traditional face-to-face approaches. We believe that the quality of education requires the integration of interactive elements which restricts the maximal number of participants considerably.

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